CLAIMS

What is claimed is:

1. An implantable hearing device comprising:

a vibrational assembly enclosed in a hermetic housing, said housing being adapted to be implanted in a human in the bone near the semicircular canals.

2. The hearing device of claim 1 further comprising:

at least one microphone;

at least one hermetic housing containing control electronics and/or a battery; and

a coil for receiving or sending data or power transcutaneously.

3. Use of the hearing device of claim 1 as a tinnitus masker, wherein said device is configured to generate a masking noise further comprising:

at least one hermetic housing containing control electronics and/or a battery; and

a coil for receiving or sending data or power transcutaneously.

4. The hearing device of claim 2 further comprising at least one electrode array.

5. The hearing device of claim 1 wherein said vibrational assembly comprises at least one controllable vibrating element, and at least one inertial mass adapted to vibrate in response to vibration of said vibrating element.

6. The hearing device according to claim 5 wherein said vibrating element comprises one or more piezoelectric components.

7. The hearing device according to claim 5 wherein said vibrating element consists of a plurality of piezoelectric elements that are substantially disk-shaped, stacked with alternating polarities, and separated by electrically conductive bonding layers which serve to connect said elements mechanically and electrically.

8. The hearing device according to claim 7 wherein said electrically conductive bonding layers extend beyond the outer circumference of said elements, thereby providing a contact pad for the attachment of wires, which serve to electrically connect said elements.

9. The hearing device according to claim 7 wherein a pair of said electrically conductive bonding layers are joined by an electrically conductive link by bending an etched metal clip to form the bonding layers and wire connecting alternating layers of the stacked piezoelectric elements.

10. The hearing device according to claim 5 wherein said vibrating element comprises one or more piezoceramic components.

11. The hearing device according to claim 5 wherein said vibrating element comprises one or more electromagnetic components.

12. The hearing device according to claim 5 wherein said vibrating element comprises one or more magnetostrictive components.

13. The hearing device according to claim 5 wherein said vibrating element comprises one or more electrostatic components.

14. The hearing device according to claim 5 wherein said vibrating element comprises one or more electrothermal components.

15. The hearing device according to claim 5 wherein said vibrating element consists of a bimorph that flexes in response to heat due to differential expansion between two or more constituent elements.

16. The hearing device according to claim 5 wherein said vibrating element consists of a material that undergoes reversible phase transition in response to localized heat resulting in volume change.

17. The hearing device according to claim 5 wherein said inertial mass is comprised of gold, platinum, iridium, lead, rhenium, or alloys thereof.

18. The hearing device of claim 1, said housing having a top that is flexible.

19. The hearing device of claim 18 wherein said vibrational assembly comprises an interconnected stack of piezoelectric crystals connected to said flexible top.

20. The hearing device of claim 18 wherein said vibrational assembly comprises a piezoelectric bimorph element connected to said flexible top.

21. The hearing device of claim 18, wherein said flexible top is composed of titanium, is about 10 to 100 microns thick, and has one or more ridges, in the form of concentric rings, which are impressed into said flexible top to increase flexibility.

22. The hearing device of claim 5 in place in an inner ear wherein said inertial mass has a vibrational axis of motion, said device being oriented such that said vibrational axis of motion is substantially perpendicular to the plane of the superior semicircular canal, with the base of said vibrational assembly positioned away from the superior canal.

23. The hearing device of claim 18 in place in an inner ear wherein said vibrational assembly has an inertial mass having a vibrational axis of motion, said device being oriented such that said vibrational axis of motion is substantially perpendicular to the plane of the superior semicircular canal, with the base of said vibrational assembly positioned away from the superior canal.

24. The hearing device of claim 5 in place in an inner ear wherein said inertial mass has a vibrational axis of motion, said device being oriented such that said vibrational axis of motion is substantially perpendicular to the plane of the horizontal semicircular canal, with the base of said vibrational assembly positioned away from the horizontal canal.

25. The hearing device of claim 18 in place in an inner ear wherein said vibrational assembly has an inertial mass having a vibrational axis of motion, said device being oriented such that said vibrational axis of motion is substantially perpendicular to the plane of the horizontal semicircular canal, with the base of said vibrational assembly positioned away from the horizontal canal.

26. The hearing device of claim 5 or 18 wherein said vibrational assembly is adapted to vibrate said housing whereby to transmit vibration through surrounding structures to the cochlea thereby causing hearing percepts when said device is implanted in a human subject.

27. The hearing device of claim 5 or 18 wherein the base of said housing is connected to a plurality of electrically insulated lead-throughs disposed through said housing base.

28. The hearing device of claim 5 or 18 wherein said housing is comprised of titanium, or alloys thereof.

29. The hearing device of claim 5 or 18 wherein said housing is substantially cylindrical in shape.

30. The hearing device of claim 5 or 18 wherein said housing contains one or more ridges and/or grooves that are radially or spirally disposed along the length of the outside cylindrical wall of said housing.

31. The hearing device of claim 5 or 18 wherein said housing is at least partially coated with a substantially compliant material.

32. The hearing device of claim 31 wherein said compliant material is silicone.

33. A microphone, enclosed in a hermetic housing and adapted to be implanted as part of a semi or fully implantable hearing device, wherein at least part of said housing is coated with a compliant material to increase the impedance to acoustic waves between said housing and the surrounding bone and tissue.

34. The microphone according to claim 33, wherein said compliant material coating said housing is silicone.

35. A semi or fully implantable hearing device, whose acoustic input mechanism comprises at least two microphones, each microphone enclosed in a hermetic housing, said housing being adapted to be implanted in bone and/or cartilage.

36. The hearing device of claim 35 in place in the side of a head wherein at least one of said microphones is implanted in the posterior wall of the external auditory canal.

37. The hearing device of claim 36 in place in the side of a head wherein at least one of said microphones is implanted substantially behind and above the auricle.

38. The hearing device of claim 36 in place in the side of a head wherein at least one of said microphones is implanted substantially near the cymba concha of the auricle.

39. A surgical method, adapted to implant a vibrator substantially between and/or among the semicircular canals and/or vestibule without breaching said canals or vestibule, comprising the steps of:

forming an approximate two inch incision in the postauricular skin crease and exposing the surface of the mastoid bone;

drilling through the mastoid until the antrum is found;

thinning the posterior canal wall, identifying the horizontal canal and drilling out a cavity superior to it; and

recessing the cavity and packing the housing of said device into said cavity using bone paste so as to promote osseointegration.

40. A surgical method, adapted to implant an implantable microphone substantially within or near the cymba concha of the pinna, comprising the steps of:

approaching the cymba through a postauricular skin incision;

raising the perichondrium on the medial side of the cymba;

removing a circular core of cartilage from the auricular cartilage while not disturbing the lateral perichondrium; and

inserting the implantable microphone and suturing the medial layer of perichondrium and the skin to cover the microphone and keep it in place.

41. A microphone, enclosed in a hermetic housing and adapted to be implanted subcutaneously in bone and/or cartilage, substantially near the cymba concha of the auricle, as part of a semi or fully implantable hearing device.

42. The microphone of claim 33 or 41 wherein at least part of said housing contains one or more circular and/or spiral grooves around its outside wall.